We claim:

Sub A1

1. A composite neutron absorbing coating on a substrate surface, the coating comprising:

a neutron absorbing layer overlying at least a portion of the substrate surface; and

a corrosion resistant top coat layer overlying at least a portion of the neutron absorbing layer.

2. The coating of claim 1, wherein the neutron absorbing layer comprises a neutron absorbing material selected from the group consisting of gadolinium, gadolinium oxide, gadolinium phosphate, and mixtures thereof.

3. The coating of claim 2, wherein the neutron absorbing layer comprises a nickel-based alloy matrix.

4. The coating of claim 3, wherein the nickel-based alloy matrix comprises nickel, molybdenum, chromium, tungsten, and iron.

5. The coating of claim 1, wherein the neutron absorbing layer comprises a composite ceramic material including gadolinium oxide and/or gadolinium phosphate.

6. The coating of claim 1, wherein the neutron absorbing layer has a thickness of about 0.2 mm to about 5 mm.

7. The coating of claim 1, wherein the top coat layer comprises a nickel-based alloy substantially free of a neutron absorbing material.

8. The coating of claim 7, wherein the nickel-based alloy comprises nickel, molybdenum, chromium, tungsten, and iron.

9. The coating of claim 1, wherein the top coat layer has a thickness of about 0.1 to about 2 mm.

10. The coating of claim 1, further comprising a bond coat layer between the substrate surface and the neutron absorbing layer.

11. The coating of claim 10, wherein the bond coat layer comprises a material selected from the group consisting of nickel-based alloys, stainless steel, boron compounds, and combinations thereof.

12. The coating of claim 10, wherein the bond coat layer has a thickness of about 0.1μm to about 0.5 mm.

13. A composite neutron absorbing coating on a substrate surface, the coating comprising:

a graded coating layer overlying at least a portion of the substrate surface, the graded coating layer comprising:

a metal alloy matrix; and

a plurality of neutron absorbing particles disposed in the metal alloy matrix such that there is a gradual decrease in the amount of neutron

absorbing particles toward an outer surface of the graded coating layer opposite from the substrate surface.

14. The coating of claim 13, further comprising a bond coat layer between the substrate surface and the graded coating layer.

15. The coating of claim 13, wherein the neutron absorbing particles comprise a material selected from the group consisting of gadolinium, gadolinium oxide, gadolinium phosphate, and mixtures thereof.

16. A composite neutron absorbing coating on a substrate surface, the coating comprising:

a neutron absorbing layer overlying at least a portion of the substrate surface; the neutron absorbing layer comprising:

a metal alloy matrix; and

a plurality of neutron absorbing particles dispersed in the metal alloy matrix, the neutron absorbing particles comprising a material selected from the group consisting of gadolinium oxide, gadolinium phosphate, and mixtures thereof.

17. The coating of claim 16, further comprising a bond coat layer between the substrate surface and the neutron absorbing layer.

18. A composite neutron absorbing coating on a substrate surface, the coating comprising:

a neutron absorbing layer overlying at least a portion of the substrate surface; the neutron absorbing layer comprising:

a ceramic material matrix ; and

a plurality of neutron absorbing particles dispersed in the ceramic material matrix, the neutron absorbing particles comprising a material selected from the group consisting of gadolinium oxide, gadolinium phosphate, and mixtures thereof.

19. The coating of claim 18, wherein the ceramic material matrix comprises an alumino-silicate material.

20. A neutron absorbing composition, comprising:

a metal alloy material; and

a plurality of neutron absorbing particles dispersed in the metal alloy material, the neutron absorbing particles comprising a material selected from the group consisting of gadolinium oxide, gadolinium phosphate, and mixtures thereof.

21. The composition of claim 20, wherein the metal alloy material comprises a nickel-based alloy.

22. The composition of claim 20, wherein the nickel-based alloy comprises nickel, molybdenum, chromium, tungsten, and iron.

23. A neutron absorbing composition, comprising:

a metal alloy material comprising nickel, molybdenum, chromium, tungsten, and iron; and

a plurality of neutron absorbing particles dispersed in the metal alloy material, the neutron absorbing particles comprising gadolinium oxide.

24. A neutron absorbing composition, comprising:

a ceramic material; and

a plurality of neutron absorbing particles dispersed in the ceramic material, the neutron absorbing particles comprising a material selected from the group consisting of gadolinium oxide, gadolinium phosphate, and mixtures thereof.

25. The composition of claim 24, wherein the ceramic material comprises an alumino-silicate material.

26. A thermal neutron absorbing storage system, comprising:

one or more internal surfaces configured to be exposed to thermal neutrons from spent nuclear fuel or other radioactive waste; and

a composite neutron absorbing coating on the one or more internal surfaces, the coating comprising:

a neutron absorbing layer overlying at least a portion of the one or more internal surfaces; and

a corrosion resistant top coat layer overlying at least a portion of the neutron absorbing layer.

27. The system of claim 26, wherein the one or more internal surfaces are on objects selected from one or more of the group consisting of storage containers, canisters, tubes, blocks, squares, baskets, and grid arrays.

28. The system of claim 26, wherein the neutron absorbing layer comprises a neutron absorbing material selected from the group consisting of gadolinium, gadolinium oxide, gadolinium phosphate, and mixtures thereof.

29. The system of claim 26, wherein the neutron absorbing layer comprises a nickel-based alloy matrix.

30. The system of claim 29, wherein the nickel-based alloy matrix comprises nickel, molybdenum, chromium, tungsten, and iron.

31. The system of claim 26, wherein the neutron absorbing layer comprises a composite ceramic material including gadolinium oxide and/or gadolinium phosphate.

32. The system of claim 26, wherein the top coat layer comprises a nickel-based alloy substantially free of a neutron absorbing material.

33. The system of claim 26, further comprising a bond coat layer between the one or more internal surfaces and the neutron absorbing layer.

34. The system of claim 33, wherein the bond coat layer comprises a material selected from the group consisting of nickel-based alloys, stainless steel, boron compounds, and combinations thereof.

35. A method of forming a composite neutron absorbing coating on a substrate surface, the method comprising:

forming a neutron absorbing layer over at least a portion of the substrate surface; and

forming a corrosion resistant top coat layer over at least a portion of the neutron absorbing layer.

36. The method of claim 35, wherein the neutron absorbing layer and the top coat layer are formed by a thermal spray process.

37. The method of claim 36, wherein the thermal spray process is selected from the group consisting of a plasma spray process, and a high velocity oxygen fuel process.

38. The method of claim 35, further comprising forming a bond coat layer on at least a portion of the substrate surface prior to forming the neutron absorbing layer.

39. The method of claim 35, wherein the neutron absorbing layer is formed from a metal alloy material, and a plurality of neutron absorbing particles dispersed in the metal alloy material.

40. The method of claim 39, wherein the neutron absorbing particles comprise a material selected from the group consisting of gadolinium, gadolinium oxide, gadolinium phosphate, and mixtures thereof.

41. The method of claim 39, wherein the metal alloy material comprises a nickel-based alloy.

42. The method of claim 35, wherein the top coat layer is formed from a nickel-based alloy substantially free of a neutron absorbing material.